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CONTENTS

"Gas" The Dr. Jekyll and Mr. Hyde of Anesthetics
Frederick Schreiber, M.D., *Detroit* 2

Message from the Secretary 5

Silicate Cement Restorations in Young Permanent Teeth
N. J. Dahn, *Big Rapids, Michigan* 6

Survey of Dental Schools
College Curriculum Survey Committee of the A.S.P.D.C. 14

Dental Health Activities in the U. S. P. H. S.
F. C. Cady, *Washington, D. C.* 19

Apicoectomy as an Aid in the Conservation of
Permanent Anterior Teeth of Children
W. H. Phillips and H. A. Maxmen, *Detroit* 21

"GAS"
The Dr. Jekyll and Mr. Hyde of Anesthetics

FREDERICK SCHREIBER, M.D., *Detroit*

Nitrous oxide is a fairly harmless gas where human tissues are concerned. In concentrations as high as 80 percent with oxygen, it has no toxic properties, but neither has it any appreciable anesthetic action in the 80 percent mixture. Why, then, is such an inert anesthetic agent used in dental surgery? The answer is that it is a good mixer, being harmless in itself but having the ability to replace and dilute oxygen in controllable amounts.

When the concentration of nitrous oxide is raised above 80 percent in an inhalation mixture of this gas and oxygen, the effects of oxygen want in the tissues put in their appearance in regular order depending on the decreasing amount of oxygen supplied to the brain. These effects, in the order of their appearance, are: dulling of the senses; disappearance of intellect, stupor; unconsciousness and anesthesia; convulsions; death—depending on how far the asphyxiation is carried. In surgery, the patient is carried to the unconscious and anesthetic stage by controlling the amount of available oxygen, i.e., by increasing the percentage of nitrous oxide in the gaseous mixture.

Normally the oxygen content of the air is about 21 percent, the other 79 percent mainly consisting of inert nitrogen. When this normal actual percentage of oxygen in the inspired air is lowered in amount to from 10 to 6 percent, it is equivalent to taking the individual up to altitudes of 24,000 to 35,000 feet within a few minutes. The patient exposed to such a decreased oxygen supply becomes unconscious in any case and may die or suffer serious brain injury from oxygen want (anoxia) in the cerebral cells, depending on the duration of the asphyxial period. The anesthetic action of nitrous oxide is due to asphyxia and not to the nitrous oxide *per se*. The effect of asphyxia on central nervous tissue is the same whether the victim is strangled, overcome by smoke, bled into unconsciousness, or given a gas mixture deficient in oxygen. It is pertinent, therefore, in discussing the use of nitrous oxide in dental practice to inquire more carefully into the physiology and pathology of oxygen want in the tissues, asphyxia being the active anesthetic agent and nitrous oxide being merely the silent and inert partner.

The first and most important effect of asphyxia is on the brain, the cells of the cortex being the first to show failure to function as a result of oxygen want. The cells in the brain stem, where the vital cardiac, breathing, and temperature centers are housed, are more resistant to the effects of anoxia, although they too succumb if the duration or severity of the oxygen want is sufficient. If there is a complete deprivation of oxygen in the cells of the

cortex for even a few minutes, these cells are permanently destroyed, their destruction being reflected in altered intelligence or behavior in the individual. If the complete oxygen want continues a few minutes longer the vital centers are affected and death ensues. That such deaths are not infrequent following the use of "gas" anesthesia for dental surgery is well known to every coroner in a large city. When the coroner's office is equipped to make comprehensive microscopic brain studies, in San Francisco, for example, the anoxic brain lesions are easily demonstrable if there is a survival period of a few hours after the asphyxial episode with gas.

The typical anoxic lesions found postmortem are "devastation areas" throughout the brain, disintegration of neural tissue being more apparent in the cortex than in the white matter. Areas of poorly staining cells, hemorrhage about small vessels, swelling about the nerve cells—all are seen in those cases in which the survival period is a few hours to a few days. If the patient survives for weeks or months and death ensues, then there may be an overgrowth of supporting tissues (gliosis), but always with evidence of dissolution of neural cells—those cells which are responsible for intellect, muscle movements, and the senses.

The author has seen patients unconscious for days and weeks after asphyxia with nitrous oxide given for a tooth extraction. Other observers have described similar cases. At the onset most of these patients showed generalized convulsions or muscle twitchings. Some were semiconscious but without intelligence. Those who remained unconscious for more than a day or two usually died. Both fatal and nonfatal cases showed an immediate rise in temperature after their asphyxial experience. Some of the survivors showed no apparent effects of their serious cerebral anoxia, while others showed permanent evidence of change in character and intelligence.

The problem of asphyxia from nitrous oxide must also be considered from the standpoint of factors in the patient which may contribute to serious cerebral anoxia when he is exposed to a gas deficient in oxygen. Sinse oxygen in the air or in any inhalation mixture is taken directly into the lungs, it is evident that the only way it can get to the brain cells is by way of the blood stream. If the oxygen supply is reduced by diluting an adequate oxygen intake with nitrous oxide, there is necessarily a deficiency of oxygen in the blood stream (anoxemia) and eventually an oxygen want in the brain cells (anoxia). An oxygen want that could be readily tolerated by a normal individual may cause serious anoxia in the anemic patient whose oxygen-bearing red cells are too few to transport an adequate oxygen supply. When the supply is curtailed both factors combined contribute toward the possibility of serious brain damage. If the blood circulation is too slow as with low blood pressure, the brain oxidation may be embarrassed to a vital degree when asphyxial anesthesia is induced. In these days of sulfanilamide and sulfapyridine popularity, it must be remembered that such drugs produce a relative anemia by the formation of methemoglobin which prevents the red cells from transporting their full quota of oxygen. If an oxygen deficient anes-

thesia is superimposed in patients with methemoglobinemia from these drugs, cerebral disaster may result.

Some patients present themselves for tooth extraction who require a great deal more oxygen than the average individual. Fever, hot weather, and exophthalmic goiter are other examples of conditions which call for a marked increase in the amount of oxygen necessary to keep body and soul together. It is obvious that when this increased demand is met with an actual oxygen deficiency in the gas inhaled, the cerebral cortex is jeopardized. A failing heart or cerebral arteriosclerosis adds greatly to the risk when the individual is subjected to asphyxial insult in dental surgery. In these cases, the brain is often already embarrassed from lack of adequate oxidation, and the shutting off of normal oxygen intake by induced anesthetic asphyxia may be the last straw before cerebral dissolution takes place.

Drugs, such as alcohol or the barbiturates, alter the ability of the cerebral cell to utilize properly the oxygen which is carried to the brain in the blood stream. It is not unusual for patients to fortify themselves with these drugs before submitting to asphxial anesthesia. The cerebral cells of such individuals are especially susceptible to any added anoxia from gas inhalations which are deficient in oxygen. Narcotics, such as morphine, depress the respiratory center so that the integration which is necessary to offset anoxemia is lacking. The first clinical signs of cerebral asphyxia are often an increase in pulse and respirations. This is nature's attempt to maintain the oxygen supply to the tissues in the face of oxygen want. The slowing of the pulse and respirations by morphine may only hasten cerebral cell destruction if asphyxial gas is used to produce surgical anesthesia.

Acting in much the same way as some of the drugs are various diseases which decrease the ability of the brain cells to make use of oxygen. The diabetic patient, especially one taking insulin, and the nephritic patient with uremia, offer distinct hazards for the addition of asphyxial anesthesia. Even the patient with a transient low blood sugar because he has missed his breakfast is more susceptible to anoxic damage from asphyxia than is one whose blood sugar is at a normal level.

Much has been written in recent months of the serious effect of nitrous oxide asphyxia on the fetus, which suggests that caution is necessary in using such asphyxial anesthesia with pregnant mothers when dental surgery is necessary. In a survey of all the children seen because of neurological manifestations unassociated with post natal infection or trauma, and excluding possible familial factors who were born within a ten-year period, the author found that approximately 70 percent had shown evidence of oxygen want at birth.* The severity of the neurological manifestations and the degree of apnea at birth were related to the accumulative effect of the combined sources of oxygen want.

It would seem that a new appraisal of the place for "gas" in dental practice should be made. Recent additions to our knowledge of the physiology

and pathology of the brain suggest that the use of any anesthetic agent which depends on asphyxia for its anesthetic effect must be carefully evaluated in the light of the known devastating effects of asphyxia on brain tissue. If such an agent is used the importance of a recognition of the many affecting factors involved in its administration cannot be too strongly stressed. The consequences of their disregard (mental and/or physical impairment) far outweigh the considerations of speed or inconvenience. In discussing "gas" as a dental anesthetic agent, benign nitrous oxide and malignant cerebral asphyxia cannot be considered separately: they are one and the same, a veritable Doctor Jekyll and Mr. Hyde.

*Details of the physiological processes and pathological changes consequent to asphyxia may be found in the following papers by the author: Apnea of the Newborn and Associated Cerebral Injury. J.A.M.A. 111: 1263, 1938. Mental Deficiency from Paranatal Asphyxia, Proc. Am. Assoc. Mental Deficiency, 44: 95, 1939.

A Message from the Secretary

One of the duties of the Secretary is the collection of dues. All members have received statements notifying them that it is again time to pay the annual dues of three dollars. The same system for paying dues will be followed this year as was employed last year—if you have a unit in your state, please send your dues to the State Secretary. This will enable each State Secretary to keep a more accurate record of the memberships in his state. In states that have no units, checks should be sent directly to the Secretary of the Society. When you receive your statement, send your check immediately and save the Society the expense of mailing you several notices.

In this connection may I call your attention to Sections 1, 4 and 5 of Article 2 of the new By-Laws which were adopted by the Society at the Milwaukee meeting, July 17, 1939.

ARTICLE 2

Section 1. Dues for active members shall be three dollars per year, payable the first day of January. Each State Unit shall pay, on or before, April 1, three dollars to the Secretary of this Society for each active member.

Section 4. Any member, not a member of a component unit, who becomes delinquent in the payment of his dues shall be notified by the Secretary at the end of sixty days. Should he continue to be delinquent for thirty days thereafter, his membership shall be declared forfeited.

Section 5. Dues of new members paid at the time of or following the annual meeting shall apply as of January the first following.

Without going into detail I would also like to tell you that the American Society for the Promotion of Dentistry for Children has just completed one of the most successful years in the history of the organization. Progress has been made on all fronts and this progress can be traced directly to the loyalty and cooperation of all A.S.P.D.C. members in furthering the interests of the organization. Prospects seem bright for even greater achievements during 1940. As Dr. Arthur H. Merritt so ably put it, "The future will depend upon what you and I do in the present."

Silicate Cement Restorations in Young Permanent Teeth

N. J. DAHN, *Big Rapids, Michigan*

Lowery[1] in December, 1938, said that for the first time in the history of the dental profession we have a working guide to the quality of silicate cements, a list[2] of those cements which meet the American Dental Association standard. When these cements are mixed according to standard techniques, they provide better translucency, less solubility, less tendency to discoloration, and have smaller arsenic contents.

Illustrating the difficulty of obtaining uniform chemical results, Paffenbarger[3] cites one prominent brand of silicate cement that was not uniform in batches of either liquid or powder, test specimens of one batch being as much as three times as soluble as specimens made from other batches. Manufacturers of certain brands have made corrections for translucency and opacity. Improvements have been made in the arsenic content of some products so that this factor is now negligible. A group of dentists are now working on experiments to demonstrate the effect of varying manipulative procedures on the time of setting, porosity, opacity, solubility, etc., as well as the relative acidity, opacity, and other properties of different trade brands.

In mixing a filling, most authorities agree that a thick glass slab should be used, as it is more apt to hold a temperature during the process. Some men advocate a slab with an enclosed thermometer, but Mamlet[4] says this is not necessary, that an ordinary thermometer for measuring room temperature is more trustworthy as a guide in mixing. Further, he believes a hygrometer to measure humidity or dewpoint is unnecessary and advocates making the mixing process as simple and practical as possible to get uniformly good fillings. The Research Commission of the American Dental Association used plain glass slabs approximately 6x3x1 inches in size, in testing these materials. Many advocate the use of an agate spatula;[5] Seides[6] suggests a stellite spatula; others make no mention of either slab or spatula. Groves[7] uses an agate slab and dislikes rustless steel for spatula or plugger. Roush[8] suggests the use of a flat water bottle for mixing. Absolute cleanliness of both slab and spatula is advocated by most men, several insisting that the slab and spatula be used for no other purpose but the mixing of silicate cements. The slab should be smooth and not scratched.

Mamlet[4] says a chemical reaction begins immediately upon mixing the powder and liquid and the speed of the reaction is controlled by the temperature and rate of addition of the powder to the liquid. An absolutely uniform process cannot be maintained in a dental office, but he suggests adjusting the mixing process to overcome abnormal temperatures. Increased temperatures hasten and decreased temperatures retard setting. A thin mix sets slower than than a thick mix, and a mix made by rapid addition of powder sets

faster. Use of these fundamental rules, he says, will enable us to make a mix of uniform setting time. A thermometer on the wall where the mixing is done is essential.

Davis[9] advises keeping the powder and liquid from the air as much as possible, stating that it is useless to attempt combining a measured amount of powder and liquid. He starts the mix with three drops of liquid on a slab at 60° F. and a little more powder than is needed. He draws three-fourths of the powder into the liquid, and after this is incorporated, he adds small amounts until the desired consistency has been obtained—i.e., the mass becomes dull but gives a gloss when patted with the spatula. Davis says the amount of powder is the only variable under our control but advises the greatest amount of powder possible for complete mortarization. He says the best fillings are produced at low humidity and temperature, with a large amount of powder in the mix.

Roush[8] points out the importance of eliminating drafts from open doors, windows, or fans during the mixing process, to prevent dehydration. Temperature and humidity conditions affect the properties of silicate cements by altering the amount of powder that can be added to a given amount of liquid. Since reducing the powder: liquid ratio of a cement increases solubility, disintegration, and setting times and decreases compressive strength, it is important that the slab be cooled to approximately 60° F. whenever the dewpoint of the air is such that water will not condense upon the slab at this temperature.[10] Seides[6] suggests a slab of 65°-70° F. if this is not below the dewpoint. If this is not possible, he would wait for a more favorable day. Ray[11] advises against the use of a slab cooled to within 5°-10° F. of the dewpoint.

The water content of the cement liquid is very important—it cannot be changed very greatly without unbalancing the reaction between the powder and liquid. These liquids are essentially aqueous solutions of phosphoric acid plus various dissolved salts. Liquids of this type tend to come into equilibrium with the water vapor in the air and thus humidity plays a big role in affecting the water content of the cement liquid. Seides[6] calls attention to the delicate balance between water in the liquid and the proper chemical reaction of the filling material. Holmes[12] has shown the susceptibility of the liquids to humidity owing to the phosphoric acid being hygroscopic. The powders are not so sensitive in this respect, therefore, proper care should be taken to safeguard the liquid from any changes after it leaves the manufacturer. Such safeguards are: tightly stoppered bottles with possibly a petrolatum film on the ground glass stoppers, and replacement of stoppers as quickly as possible after every withdrawal of liquid. Paffenbarger Schoonover, and Souder[10] suggest placing a few drops of oil such as U.S.P liquid petrolatum in the liquid. The thin film of oil on the surface of the liquid prevents unbalancing of the water content. The pipet should be

inserted beneath the oil film before withdrawing any liquid and the outside wiped off with a clean cloth to remove excess oil.

The mix should always be made immediately after placing the liquid on the slab. Paffenbarger, Schoonover, and Souder[10] say: "The effect of humidity is comparatively slight, if the mix is made immediately after the liquid is placed on the slab." Seides[6] also says the mix should be made as soon as the material is placed on the slab. Holmes[5] reiterates this thought. Tingley[13] suggests postponing the filling operation if the humidity is such that the dewpoint is higher than 75° F. Davis[14] suggests taking the slab from iced water (40°-60° F.) quickly drying and transferring to a second dry towel, then lifting the towel from the working half of the slab and coating it lightly with petroleum, using a finger. A bath of spirits of chloroform will take care of condensation with a slab as low as 50° F. when the humidity is not over 60.

Most men emphasize the importance of absolute cleanliness about the neck of the liquid bottle. Crystals that collect should be wiped away. Such material, if allowed to enter the bottle, seriously unbalances the liquid. Crowell[15] points out that the darkest gray owes its color to one part of pigment for 5,000 parts of base. From this, it is apparent that even minute amounts of dirt will affect the shade of the finished filling.

It is impractical for the average dentist to install equipment for accurately weighing the amount of powder and liquid for each mix. Several measuring devices have been suggested, but many dentists guess at the amount to use, judging by the consistency of the mix. A stiff putty-like consistency is generally advocated. One manufacturer includes a dropper that measures the drops quite accurately and a device that measures the amount of powder for this dropper. This seems to be quite a practical device for the average dentist to use in his office.

The mixing technique used by Paffenbarger, Schoonover, and Souder[10] representes the combined data secured from the manufacturers and the dental profession. They use 0.4 cc. of liquid and an amount of powder determined by the consistency. About half of the total mass of powder is drawn into the liquid and spatulated for about fifteen seconds, another quarter drawn in and spatulated for another fifteen seconds, then the remainder is added and spatulated for thirty seconds. The mixing time is one minute with nearly half the top surface of the slab used in making the mix. Every portion of powder is thoroughly incorporated with no unused powder or liquid left on the edges. A rotary motion in combination with a linear motion is used, with light pressure on the spatula. Occasionally the mass is picked up and deposited in a heap and the process repeated. Air bubbles will be present but they can be kept at a minimum by a mixing technique in which beating or folding motions of the spatula are eliminated as much as possible. Seides[6] uses a light rotary motion of the spatula, held flat against the surface of the slab until some resistance is felt. The mass is gathered on the spatula and kneaded on the slab by turning the handle of the spatula

firmly over the mix. He mixes to a consistency that curls under the spatula but shows a glossy surface when patted.

Contrary to the belief of older writers, Paffenbarger, Schoonover, and Souder[10] found that the rate of adding the powder when mixing does not appreciably affect the time of setting. Lengthening the time of mixing increased the setting time. Eberly[16] recommended a short mixing time. Tingley[13] recommends forty seconds for mixing, twenty seconds for testing and combining the mass, and sixty seconds for placing in the cavity and under pressure. Seides[6] uses not over one minute for mixing. Berman[17] says mixing and insertion should be done within one minute.

Tingley[13] says the reaction of the liquid and powder of a silicate cement is a heterogeneous reaction following the Noyes-Whitney equation. There are several variables in this reaction. The manufacturer controls the grind of the powder and the original concentration of the liquid. The dentist can do several things that can change the intended normal reaction, such as shortening or lengthening the diffusion distance or changing the acid concentration by his technique of manipulation. He reminds us that the plasticity period of this material is only a matter of seconds, but that this quality of plasticity is a very helpful factor in the thorough adaptation to the cavity walls.

Most authorities feel that the material should be inserted into the cavity as quickly as possible after arriving at the proper consistency in mixing. Most men like to have strips or matrices in position or in readiness so that no time will be lost in placing the completed mix in the cavity. Here again, the rubber dam is almost indispensable. It will keep the tooth dry so that when the mixing is completed, the filling can be inserted promptly, without having to stop to dry the cavity as so often happens when trying to work without the rubber dam in place. Matrices can also be used to better advantage with the rubber dam in position to hold lips, tongue, and gums out of the way.

Felsher[18] points out the use of modeling compound as a matrix for silicate fillings. Rinehart[19] places the strip and then carries a small amount of the cement to the entire base of the cavity. This is followed by a second application, being sure no air chambers have been created, then filling to overflowing and compressing with the strip. Roush[8] feels that the mix should be held near the cavity by the nurse to prevent dehydration in carrying small amounts through the air from the slab to the tooth.

Best results are obtained if only one filling is made from a mix. Roush[8] points out that if more than one is made from a single mix, the second filling will not be as good as the first. Crowell[15] points out the danger of too much pressure against the thin wall of dentin when applying the strip. He strengthens the floor of the cavity by a zinc cement lining. Smith[20] feels that pressure makes a much more dense and translucent filling. Crowell[15] warns against inserting a silicate filling into a cavity that has been dessicated or dried too much, since the dehydrated dentin will withdraw liquid from the cement

and change the delicate balance of the material. Faggart[21] suggests for a Class V filling that the cavity be filled with inlay wax and shaped, then a modeling compound impression of the labial surface of the tooth should be taken, the wax removed, and the filling inserted to a slight excess, the compound impression placed and held as a matrix until the material has set. Goldstein[22] suggests the use of an ordinary penpoint as an ideal matrix for silicate cement fillings on the labial and buccal surfaces of the teeth. He bends and grinds the blunt ends for an assortment of sizes, and coats them with cocoa butter.

Most men now advocate the use of an uncoated strip for silicate fillings. Several have pointed out the danger, when using a coated strip, of getting some of the coating on the cavity margin. This would prevent the filling from sealing the cavity properly. Seides[6] suggests spending a little time in trimming the strip for a Class III to form a well fitting matrix. This he adjusts and retains in place by a small wooden wedge, by packing some cotton against it, or by using modeling compound. Mamlet[4] requires only 15 to 20 seconds to place the filling in the cavity. He covers the floor and walls thoroughly and then adds sufficient to fill to a slight excess, working toward and against the margins, then drawing the strip tight and holding for three minutes, never burnishing over the strip. After removing the strip, he immediately covers the filling with a thick layer of white vaseline or petrolatum leaving for ten minutes. Melting cocoa butter or paraffin causes a slight delay and surface shrinkage, he believes, owing to a slight loss of water. Seides[6] uses very little pressure on the strip but holds it for three minutes. He remakes the filling with fresh liquid if it requires over five minutes to set. He avoids burnishing, pressure, great traction, or lifting of the matrix.

Davis[9] advises overfilling of the cavity, patting and tamping to place, smearing with oil (kind not mentioned), and pressure of 10 to 15 pounds applied for fifteen minutes, then trimming with knives, files, and burs, leaving the rubber dam in place for thirty minutes after the mix is begun. He says the instruments and appliances for applying pressure are easily made by the dentist and are not on the market. He does not tell how to make them or what materials to use. He says strips should not be used on Class III fillings. He thinks the surfaces of all silicates expand if exposed to moisture in a saturated atmosphere during the first thirty minutes after mixing. Berman[23] advises the use of a mechanical separator for Class III cavities in adjacent teeth. After filling one cavity, he uses an orangewood wedge at the contact point to maintain the separation while changing the separator so the other cavity may be filled.

The length of time to confine the material with matrices depends on the setting time of the cement, which should be within rather narrow limits. Paffenbarger, Schoonover, and Souder[10] suggest a five minute setting time as ideal but because of the nature of the material would allow a tolerance of from three to eight minutes. Tingley[13] recommends holding for five minutes under pressure. If the matrix is removed prematurely, it produces a rough

surface on the filling and breaks the contiguity; if saliva contacts the filling before hard, a soft, opacified, and porous surface is the result, a nearly worthless filling. To state it differently, when a cement is exposed to liquid before setting sufficiently, its surface area expands and becomes soft, porous, and opaque. Portions not in contact with water shrink, especially if made with a liquid of low water-content. This is readily explained by the affinity of the phosphoric acid for water. In an incompletely set cement, some of the uncombined phosporic acid of the mix unites with the water and interferes with the chemical reaction of the powder and liquid, resulting in an unsatisfactory filling. Paffenbarger, Schoonover, and Souder[10] found one slow-setting cement that was not safe to expose to water even twenty-six minutes after its initial setting time. Neither may these fillings be exposed to the air until they have set properly for then there is a loss of moisture and shrinkage takes place in the filling. Cocoa butter, vaseline, petrolatum, paraffin, and varnishes are advocated for use immediately after removal of the matrix to prevent loss of moisture. Cocoa butter and paraffin have been objected to because of the necessity of melting them by heating. Even this momentary delay gives opportunity for loss of the fine balance of water in the mix. A modified cocoa butter, vaseline, or petrolatum seems to answer these objections. Varnish is objected to by Mamlet[4] because most varnishes contain alcohol, acetone, or other dehydrating agents.

It is wise to leave the rubber dam in place for a period long enough to insure the initial hardening of the particular cement being used. This period has been determined for various cements. Before removal of the rubber dam, many authorities suggest the thorough varnishing of the tooth and filling. When dry, the rubber dam should be cut and not pulled over the tooth. This protects the varnish so that a proper seal is provided for a few hours. Some men advise their patients not to brush the filled tooth until the following day to avoid disturbing the varnish.

Groves[7] doubts the efficacy of varnish and suggests sticky wax or a solution of celluloid to keep the filling free from moisture for 15 to 30 minutes. Holmes[5] protects the filling from moisture for at least thirty minutes after the initial set with molten wax or varnish. Eberly[16] keeps the filling dry for seven minutes and then exposes it to saliva without a protective medium, feeling that water is possibly essential for a continuation of the hardening process. Lewis[24] uses a covering of a solution of cellulose in amyl acetate instead of varnish. He polishes after ten minutes and while the rubber dam is still in position.

Most men advocate the finishing of silicate cement fillings at a subsequent appointment—from several hours to several days later. This allows the filling to harden thoroughly. Many men feel that the best silicate fillings are those that need no finishing but are perfect when the strip is removed. Some admit they cannot infallibly estimate the proper amount of material to use and their fillings require a certain amount of finishing. Seides[6] feels, with Groves[7], that a better filling is one that had the matrix adjusted so well

that finishing is unnecessary. He calls attention to the varying degrees of hardness and the lack of homogeneity of the set silicate and the resulting resistance to the abrasive action of the polishing and finishing instruments. He cautions us not to remove the rubber dam until the varnish is completely dry.

Many advocate the use of coarse sand strips and discs well lubricated with vaseline, cocoa butter, or petrolatum for trimming the gross excess away or even the use of fine stones for this purpose. Mamlet[4] believes, with Seides[6], that chisels or hand cutting instruments damage margins. They remove excess material with coarse discs or strips, well lubricated with vaseline to prevent dehydration. Final finishing is done with fine sand and then cuttle strips and discs, always well lubricated. Mamlet[4] polishes from the tooth toward the filling and says silicate fillings get stronger up to 28 days or more and that the best time to polish them is when they are hardest. Fine alpine points are suggested for this purpose also.

The filling must be finished flush with the enamel walls of the tooth. Paffenbarger, Schoonover, and Souder[10] report no significant difference in the solubility and disintegration of polished and unpolished test specimens. Apparently polishing does no harm from the standpoint of solubility and disintegration. Gibson[25] polishes a silicate filling with "Caulk's dental polish" on a felt cone.

When two adjacent cavities are being filled at one sitting, it is necessary to protect one while filling the adjacent one. This is readily accomplished by the use of a celluloid matrix and a little care on the part of the operator. Two cavities should never be filled from the same mix. Previously placed silicate cement fillings must be protected if the teeth are to be dried, as drying irreparably damages these fillings. They are irreversible colloids and once dried, never completely come back when again moistened. It is necessary, then, either to keep them moist or to cover them with a material that will prevent their drying. Most men use a coating of varnish for this purpose. Mamlet[4] advocates a double coating of varnish for this purpose. Seides[6] uses a heavy coating of varnish. Tingley[13] calls the silicates irreversible colloids —which, if called on during their period of hardening or later to give up some of the water of gelation, undergo serious structural and physical change. Attempts to replace the water thus lost will be only partly successful.

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A. S. P. D. C. News Items

Dr. Walter McFall recently bought out the practice of Dr. Louis Mann and will devote his time to the exclusive practice of Orthodontia. Dr. McFall's new address is 701 Flatiron Building, Asheville, North Carolina.

Twenty-five new members from Tennessee have just been added to the roster and a State Unit will no doubt be organized in the near future.

Dr. R. M. Erwin, Jr. and Dr. Floyd DeCamp appeared on the fall program of the South Eastern Washington Dental Society.

The State Board of Dental Examiners of Tennessee has recently decided to include questions on Children's Dentistry in all future State Board Examinations.

Dr. John C. Brauer appeared on the program of the Golden Gate Dental Congress held in San Francisco in September.

Dr. Jules Page, recipient of the Certificate of Merit from Montreal University, has recently affiliated himself with the A.S.P.D.C.

Dr. Louis E. Schricker has been elected Secretary of the new Minnesota Unit, and Dr. J. H. McTague is the new Secretary of the Maine Unit.

December 14, Dr. K. A. Easlick, of the University of Michigan School of Dentistry, addressed the Detroit District Dental Society upon "The Pre-School Child's First Appointment."

Survey of Dental Schools*

From the 1939 Report of the College Curriculum Survey Committee of the American Society for the Promotion of Dentistry for Children

KENNETH A. EASLICK, *Chairman*

To obtain the opinions of the teachers of Children's Dentistry, questionnaires were mailed to the 44 schools in the United States and Canada. Of these 44 schools, 10 schools failed to reply, 32 schools filled out and returned the questionnaires, and two schools replied that their programs in Dentistry for Children were not sufficiently organized to fill out the questionnaire.

UNDERGRADUATE INSTRUCTION

1. Hours devoted to lectures (31 replies):

Number of hours	68	48	33	32	28	27	24	22
Number of schools	1	1	1	7	1	1	1	1
Number of hours	18	17	16	12	10	8	6	0
Number of schools	1	2	5	2	1	3	2	1

2. Given to: Seniors by 11 schools, juniors by 12, juniors and seniors by 6, and to sophomores by 1.

3. Semester given:

Semester number	1	2	1 and 2	1, 2, and 3	2nd Quarter	2nd & 3rd Quarters
Number of schools	12	1	14	1	1	1

4. Presented as a separate course by 20; separately and part of Operative Dentistry by 1; as part of Operative Dentistry by 7; as part of Operative Dentistry and Orthodontics by 2; and as part of Preventive Dentistry by 2. (Fourteen schools' replies did not approve of Children's Dentistry as a part of a course in the "Application of Preventive Principles"; 6 answered "Yes"; one qualified with "if procedure revised"; and one stated "Embody preventive principles in course in Children's Dentistry.")

5. Lectures given by:

Title	*Professor*	*Asst. Prof.*	*Instructor*	*All 3*	*Associate and Lecturer in Pedodontics*	*Director of Children's Dept.*
Schools	7	10	5	1	1	1

6. Name preferred for course (number of schools favoring each name follows in parentheses): Children's Dentistry (4); Dentistry for Chil-

*Some of the 32 schools which returned a "questionnaire" did not answer every question. Data presented herein are based upon the number who answered the particular question.

dren (3); Children's Dentistry or Pedodontics (2); —or Pedodontia (2); Pedodontics (6); Pedodontics or Pododontia (5); Pediodontia (3); Dental Pediatrics (5); Pododontology (1).

7. Objectives in the course consist in the presentation of material on the following: Child management, 32 schools; modified operative procedures for deciduous and young permanent teeth, 32 schools; problems of growth and the control of child development which relate Children's Dentistry to Nutrition, Pediatrics, and Orthodontics, 25; dental health education of the child and parent, 26; diagnosis, 6; office management and the business side of practice, 4; extractions and minor oral surgical procedures, 4; prevention in terms of local conditions which influence future disease of the mouth, 2; an attempt to enthuse or inspire students to desire to do the best type of children's work, 1; and, teach public health and public dental health, 1.

8. Nutrition: Incorporated with Children's Dentistry Lectures.

Hours	1	1*	2	2*	6	8	?	0
Schools	1	1	2	1	1	2	1	5

*Plus a separate course.

Given as a separate course

Hours	6	16	32	?	0
Schools	1	3	1	12	5

9. Twenty-nine answers stated that the lectures reviewed the pulp chamber and surface anatomy of the deciduous teeth; two answered "no."

10. A review of embryology is given by 16 schools; not given by 13; "some" or "briefly" by 2; and as a separate assignment by 1.

11. Sixteen schools require purchase of a syllabus or text on Children's Dentistry; 16 do not.

12. Assignments for the review of literature on Children's Dentistry are made by 23 schools; not made by 6; and attention is called to articles by 1.

13. Examination Methods:
Quizzes are given in 23 schools; midsemester examinations in 18; final examinations in 23; assigned reports in 14; three examinations per year in 1; 2,000 word report in 1; no examination in 1.

CLINICAL OPERATIVE DENTISTRY

1. Separate children's clinic?
Yes, 18 schools; no, 13; part separate and part with adult clinic, 1.

2. Hours devoted to children's work in clinic:
Only one school replying requires children's work in clinic during the sophomore year (32 hours); 9 of 32 schools devote no time in clinic during the junior year, 7 did not specify amount, and 13 schools devote

from 10 to 270 hours; 9 schools did not specify the number of hours devoted to children's work in clinic during senior year, 17 devote from 20 to 120 hours.

3. Same schedules of fees in children's and adult clinics?
Yes, 11 schools; no, 18; free, 2; yes, except for prophylaxis, 1.

4. Separate record forms in children's clinic?
Yes, 17 schools; no, 15.

5. Non-cooperative patients are taken to private operating room in 11 schools; sent home in 7; allowed to remain in general clinic in 6; sent home or remain in general clinic in 2; sent home or taken to private operating room in 1; taken to private operating room or remain in general clinic in 2; not allowed in clinic in 1; too few to mention in 1.

6. Radiograms are used occasionally in 20 schools; in most cases in 1; routinely in 11.

7. Radiographic examinations are made of the full mouth in 5 schools; full mouth and posterior bitewings in 8; posterior bitewings in 8; posterior bitewings and profile in 1; posterior bitewings, full mouth, and lateral jaw plates in 1; posterior bitewing, full mouth, and diagnostic in 1.

8. Bacterial studies of children's salivas are made routinely in one school; occasionally in 6; not made in 24.

9. Prophylaxis is the usual introduction of a small child to Operative Dentistry in 30 of 32 schools.

10. Toothbrushing is taught each child in 23 schools; on request in 1; not routinely in 3; not taught in 5. Brushes are provided in the dispensary by 15, are not by 16.

11. Twenty schools attempt to utilize pleasant tastes in polishing paste, etc.; 10 do not; one, "to some extent."

12. Definite attempt to teach child's parents what constitutes a good mouth health program? Yes, 21 schools; no, 6; occasionally, 2; when possible, 1; by student, 1.

13. Dietary advice is given by a student in 3 schools; student and department of nutrition in 2; student and instructor in 10; instructor in 6; instructor and department of nutrition in 1; only after consultation with division head in 1; not given in 2.

14. Examination of the occlusion is included in each child's examination in 29 schools; not included in 2; not routinely in 1.

15. Casts of each child patient's mouth are made by 6 schools; are made occasionally by 1; not routinely by 2; not made by 22.

16. Space maintainers are constructed in the children's clinics of 21 of 31 schools; through the department of orthodontics in 1.

17. Approximating cavities in two deciduous molars are occasionally filled with one amalgam filling in one school; are not in 31.

18. Infected deciduous teeth are sometimes opened for drainage and left to hold space in 4 schools; are not in 28.

19. In 18 schools, silver amalgam was the only material given as used routinely for two-surface fillings; low-cost metal inlay was reported by 2; other or more than one material was given by 11 schools (silver amalgam was included by 8, copper by 5).

20. Silver nitrate solution is reduced routinely in deep cavities in posterior deciduous teeth by 15 schools; not used routinely by 9; not used by 8.

21. Interproximal cavities in anterior permanent teeth of children 7 to 12 years old are filled with: zinc phosphate or silicate cement in 7 schools; silicate cement in 6; silicate cement or gold foil in 1; silicate cement or silver amalgam in 1; silicate cement or Kryptex in 1; Kryptex or silver amalgam in 1; Germicidal Kryptex or copper amalgam in 1; Kryptex in 1; white copper cement in 1; zinc phosphate cement, Kryptex, or silicate cement in 1; amalgam in 1; zinc phosphate cement in 1; silicate cement or gold inlay in 1; zinc phosphate cement or Kryptex in 1; zinc phosphate cement, Kryptex, or silver amalgam in 1.

22. Treatment used routinely for vital exposed pulp in preschool child's deciduous molar: extraction in 8 schools; pulp capping in 8; vital pulpotomy after local anesthesia in 8; pulpotomy after devitalization in 17; root canal filling after devitalization in 6; most convenient method in 1; according to case in 1. Radiographic "checkups" are used by 19 schools; when possible by 2 more; frequently by 1; when necessary by 1; not used by 3. For devitalization, 11 schools use paraformaldehyde; 6 use arsenic; 1 uses phenol; 1 uses Lilly's desensitizing paste.

23. Treatment used routinely for a vital exposed pulp in a first permanent molar that has incompletely calcified: extraction in 8 schools; pulp capping in 13; vital pulpotomy after local anesthesia in 17; pulpotomy after devitalization in 3; pulp extiration after low pressure anesthesia, plus a root canal point filling in 1; pulp extirpation after local anesthesia, plus a root-paste filling in 1. Arsenic is used for devitalization by 2; paraformaldehyde by 1.

24. Attitude toward treatment of putrescent deciduous molars? Ten prefer extraction; 13 treat a few selected cases; 8 treat 40 to 60 percent of cases. Three obtain negative cultures, 15 do not. Radiographic "check-

ups" are obtained routinely by 13; frequently by 1; when possible by 2; not obtained by 5.

25. Of the 32 schools replying, almost as many different formulae were given for the treatment of Vincent's Infection in a small child's mouth.

26. General anesthesia is available for extraction of the teeth of small children in 30 schools (Department of Oral Surgery only in 1); not available in 2. In 26 schools trained anesthetists administer the anesthetics; in 1 "trained anesthetist for nitrous oxide and practical instruction of students for ethyl chloride; no trained anesthetist in 2. Nitrous oxide is used by 16; nitrous oxide, ethyl chloride by 9; nitrous oxide (1), ethyl chloride (2) by 1; ethyl chloride by 2.

27. In 19 schools, an attempt is made to teach the student physical diagnosis in the children's clinic; in 1 "in a general way"; in 2 the attempt is limited; in 10 no attempt is made.

DENTAL ANATOMY AND TECHNICS

1. Anatomy of deciduous teeth is taught in regular course in dental anatomy in 30 schools; "a small amount" in 1; not taught in 1.

2. Deciduous teeth are carved in the regular course in 24 schools; are not in 7.

3. Twenty schools teach technics in the regular course which have special application to a children's practice; 10 do not.

4. Ten schools devote 10 percent or less of the regular course to deciduous teeth; 4 schools devote 16 to 25 percent; 1 school, 31 percent; 1 school, 40 percent; 1 school, 50 percent; 1 school, 60 percent; percent of hours not stated by 6 schools.

5. Additional technics are taught by the department of Children's Dentistry in 15 of the 25 schools answering the question. One school devotes 4 hours in the sophomore year; one, 15 hours; one, 3 hours; 19 devote no time in that year. In the junior year, one school gives 5 hours' instruction; one, 48 hours; one, 60 hours; 17, none. In the senior year, one school provides 3 hours; one, 4; one, 18; 17, none.

A resume of the post-graduate instruction offered in the dental schools which answered the questionnaire will be published in the second quarter issue of the REVIEW

Dental Health Activities in the United States Public Health Service*

F. C. CADY, *Washington, D. C.*

The U. S. Public Health Service is a part of the Federal Security Agency in direct charge of the Surgeon General, whose acts are subject to supervision and approval by the Administrator. As organized at present, the Surgeon General administers the affairs of the U. S. Public Health Service through eight administrative divisions. These are: (1) Division of Marine Hospitals and Relief; (2) Division of Domestic Quarantine (States Relations); (3) Division of Foreign and Insular Quarantine and Immigration; (4) Division of Personnel and Accounts; (5) Division of Sanitary Reports and Statistics; (6) Division of Venereal Diseases; (7) Division of Mental Hygiene; (8) Division of Scientific Research, which includes the National Institute of Health.

Dental personnel are detailed to four of these division,s viz: Division of Marine Hospitals and Relief, Division of Domestic Quarantine (States Relations), Division of Mental Hygiene, and the Division of Scientific Research. Dental public health services are largely confined to the Division of Domestic Quarantine (States Relations) and the Division of Scientific Research.

Joint responsibility for the control and prevention of the spread of disease began in 1893 when the Congress passed a law directing the Surgeon General of the U. S. Public Health Service to cooperate with and aid State and municipal health authorities in the enforcement of health regulations of such authorities. Not until the enactment of the Social Security Act in August of 1935, however, had there been adequate recognition by the Federal government of its share of responsibility in dental health matters.

In addition to grants-in-aid to the States for the establishment of dental health services and the training of personnel, the U. S. Public Health Service through its Division of Domestic Quarantine (States Relations) has added a dental consultation service to provide advice on the organization and administration of dental health services in State and local health departments. This cooperation also extends to the assignment of Service officers, on request from States, to duty within the States.

At the National Institute of Health several studies involving dental or stomatological problems are being conducted. Problems under investigation include endemic dental fluorosis, Vincent's infection, and dental caries.

The basic epidemiology of endemic dental fluorosis has been largely completed and major activities in this field have been directed to a study of the relation of endemic fluorosis to dental caries. Studies in field epidemiology, oral bacteriology, and animal experimentation are being conducted with

*Excerpt from unpublished Public Health Bulletin No. 251 by Frank C. Cady Dental Surgeon, U. S. Public Health Service.

respect to the relationship of the mineral composition of the communal water supply to the severity of dental caries in different communities.

The studies on Vincent's infection, experimental production of dental caries, and nutritional studies on fluorides in food and drinking water are coordinative studies of the Division of Infectious Diseases and the Section of Nutrition, Division of Chemistry, at the National Institute of Health.

Trained dental officers are also detailed to the Division of Public Health Methods, National Institute of Health:

1. To determine quantitatively the prevalence of the disease, dental caries, in the child population of the United States as a whole and to identify variations in prevalence in respect to specific localities and areas. The development of knowledge in respect to this question has necessitated the adoption of basic definitions by means of which the dental status of children may be measured.
2. To determine quantitatively certain basic characteristics of a child population in respect to the development of their dentitions.
3. The development of methodologies by means of which the status of the dental problem in children may be rapidly ascertained.
4. The development of methods which will delineate the mathematical laws governing the process of attack of teeth by caries.

The Division of Sanitary Reports and Statistics through the Office of Health Education is engaged in studies for more effective means of imparting information on dental health. An important phase of the educational work is the publication of the "Health Officer" which contains a section on dental health. "Public Health Reports," a weekly publication of the U. S. Public Health Service, provides information on the Service investigations of dental diseases and dental public health methods. This Division also prepares exhibits of dental health activities for National and State dental and public health meetings.

TEMPLE UNIVERSITY TO HAVE CHILDREN'S DENTAL CLINIC

Through the generosity of Mrs. Emilie Foster Klahr, Philadelphia, an enlarged Children's Dental Clinic in the Dental School of Temple University has been made possible. The gift, announced recently by Dr. I. Norman Broomell, Dean of the Dental School, provides for the purchase and installation of a number of new chairs and operative units, which will result in creating an enlarged and more highly efficient department, operating as a distinct unit for the treatment of the teeth of children.

The new equipment will enhance not only the interest of students in the subject of Children's Dentistry but, also, will attract the interest of the little patients to be served. The new department will occupy the space which formerly housed the library on the first floor of the Dental School Building.

Apicoectomy as an Aid in the Conservation of Permanent Anterior Teeth of Children

W. H. Phillips and H. A. Maxmen, Detroit, Michigan

Apicoectomy or root resection is the amputation of the apex of a tooth root[1]. However, in the broader sense it implies not only the amputation of the apex of a tooth root, but, also, the surgical removal of all necrotic periapical tissue.

The literature contains numerous articles describing various techniques of apicoectomy on single rooted teeth for adults, but little has been written about the possibilities of apicoectomy as a means in the conservation of permanent anterior teeth of children. Blum[2] in his report of 159 cases mentions only one child of ten years receiving an apicoectomy. Feldman[3], Coolidge[4], Hill[5], Sommers[6], Colton[7], McGehee[8], and Mead[1], fail to report any children having received apicoectomies.

The dentist who is called upon to render an acceptable dental service for a child, who, as the result of caries or accidental fracture, presents a devital permanent anterior tooth which on radiographic examination is found to have periapical involvement, is confronted with but two choices of procedure. One choice is to resort to root canal therapy and apicoectomy. The other choice is to extract the tooth and replace it with either a removable bridge, a partial denture, or an orthodontic space maintainer, to which is soldered a pontic with a porcelain facing. Fixed bridgework which necessitates cutting into adjacent young permanent teeth for anchorage is certainly contra-indicated. Since no substitute is as good as the child's own tooth, it is obvious that every means that modern dental science has made possible should be resorted to in order to retain the child's tooth, and at the same time to render the tooth inocuous as a potential focus of infection. Although the retention of devital teeth is still a debatable question among dental authorities, there are, nevertheless, many indications for the tenability of these teeth, especially single rooted permanent teeth of children.

The primary purpose of this paper is to present a simple, rational technique of apicoectomy for children, devoid of the usual complicated and impractical procedures so commonly advocated by many authors on this subject. Since there is such a paucity of articles dealing with this subject, we are led to believe that little effort is being made to utilize this valuable aid in the preservation of permanent anterior teeth of children. The technique herein presented is based upon the experience gained in the treatment of 1,746 permanent anterior teeth of children during four years in the Detroit Department of Health and Children's Fund of Michigan Root Canal Therapy Clinic.

From March 19, 1936, through November 30, 1939, 1,911 underprivileged Detroit school children have received root canal treatment from this clinic. During this period, 1,746 root canals were filled and 449 teeth were

resected. The children on whom root resections were performed ranged from seven to eighteen years of age, although the majority of cases fell into the age group 12 to 16. Failures, based upon failure of complete regeneration of the periapical alveolar bone, have been limited to five of 449 resected teeth. Two failures were due to use of silver points as the primary root filling material. The silver points became loosened during the process of resection, and, consequently, failed to hermetically seal the amputated end of the root. These two teeth were refilled with gutta percha and Kerr Sealer, using the sectional method. Six months after repeating the resection, bone regeneration was complete. Two other failures involved resecting two teeth in which the root canal filling was not properly condensed. These two teeth had been restored by means of Davis crowns and the root canals were filled outside of the clinic. The fifth failure resulted from traumatic occlusion, and the destruction of more than two thirds of the peridental membrane.

Before presenting the technique for apicoectomy, it is essential that we discuss briefly the indications, contra-indications and pre-requisites that should be observed in securing successful apicoectomies on permanent anterior teeth of children.

Indications for Apicoectomy

1. The child's health should be the predominating factor[9].
2. All devital single rooted teeth with infected periapical areas, granulomas or radicular cysts. Granulomas seldom, if ever, undergo spontaneous resolution[8]. The capsule must be removed by surgical means. If allowed to remain, these residual areas of infection are of great danger to the patient, likewise for cysts.
3. Roots fractured in the apical third.
4. Badly curved roots that are difficult to fill completely.
5. Partially obliterated and obstructed root canals.
6. Foreign bodies in the apical end of root canals, such as broaches or reamers.
7. Young permanent anterior teeth with incompletely developed roots and wide open apical foramena.
8. Overfilled or underfilled roots of single rooted permanent teeth.
9. To prevent the collapse of space when a child is too young for bridgework.
10. To preserve esthetics, function and prevent malocclusion.

Contra-Indications for Apicoectomy

1. Children known to have dibilitating diseases such as; diabetis, a blood discrasia, or migrating osteomyelitis.
2. Children having hypertrophic, recessive, suppurative, ulceromembranous, systemic or streptococcic gingivitis.
3. Teeth with fractured crowns extending into the root.
4. Teeth with excessive caries extending into the pulp chamber floor.
5. Teeth in which destruction of the peridental membrane has progressed

more than two-thirds of the way down the root toward the crown thereby jeopardizing retention.
6. Teeth with poorly condensed root canal fillings.
7. Teeth in traumatic occlusion which cannot be properly corrected.
8. No matter how slight the periapical involvement, a pulpless tooth which interferes with the eruption of a normal tooth should be extracted.

Pre-requisites for Apicoectomy

1. A clear and accurate radiogram is absolutely necessary. However, the radiogram cannot be relied upon to disclose the entire extent of the periapical bone envolvement. Invariably, the periapical bone involvement is much more extensive than the radiogram would seem to indicate. A good radiogram does, however, show the length and position of the root and the density, length and adaptation of the root canal filling, and the proximity of adjacent roots.
2. A dense root canal filling of gutta percha involving the point of resection. This point cannot be overemphasized as the prognosis of the resection depends more upon this factor than all others contained.
3. All teeth indicated for extraction should have been removed.
4. All teeth indicated for filling should have been filled.
5. No evidence of stomatitis or respiratory infection.
6. Preparation of the Patient:
   a) Premedicate to alleviate apprehension and produce mental quietude and cooperation.
   Elixir Alurate (Roche) or Elixir Nembutal (Abbott) one teaspoonful for each 5 years of age, *i. e.*, 7½ years, 1½ teaspoonfuls, 10 years, 2 teaspoonfuls, etc.
   b) The child is told briefly what is to be done and why we are going to do it, and the necessity of keeping his hands away from the face during the operation.
   c) The child's face is washed with soap and water followed by 70% alcohol. Keep the alcohol away from the patient's eyes. The child is again warned about keeping his hands away from his face.
   d) The child's hair is covered with a sterile towel. A rubber exodontia apron is placed over the front of the patient, and a sterile towel used as a bib is placed over the rubber apron.
   e) The mouth is sprayed with solution of merthiolate 1:1000 (Lilly's) by means of an atomizer.
7. Aseptic technique must be used throughout the operation.
   a) All instruments that are to be used in the operation must be sterilized immediately before being used and placed on a sterile towel on the instrument tray. All surgical instruments that would not be injured by heat must be boiled ten minutes. Cutting instruments such as scalpels, scissors, chisels, and burs must be sterilized by complete immersion in metaphen sterilizing solution or 70% alcohol for 20 minutes. The handpiece sheath must be sterilized by immersion

in metaphen or alcohol for 20 minutes, placed on the spindle and covered with a sterile towel until ready for use. All supplies such as sponges, gauze squares, applicators, rubber gloves and towels must be autoclaved for fifteen minutes at 15-18 pounds pressure.

b) The operator must scrub his fingers, hands, and arms to the elbow for ten minutes. Sterile rubber gloves may be worn as protection for the operator. During the operation the operator must be careful not to touch anything outside of the field of operation in order to avoid contamination.

c) The dental assistant makes all adjustments to the chair and headrest during the operation, and generally assists the dentist by handling all unsterile equipment such as the emesis basin, instrument forceps, radiographs, opening packages of sterile sponges and tightening the handpiece chuck screw, etc.

Techniques employed in Detroit Board of Health and Children's Fund of Michigan Root Canal Clinic.

Two techniques are employed in the clinic: (1) the conventional pre-operative canal filling technique in which the root is resected *after* the root canal is filled, and (2) the post-operative canal filling technique in which the root is resected *before* the root canal is filled. The pre-operative canal filling technique has been the procedure employed with the majority of teeth resected in the clinic.

Conventional Root Resection Technique by Steps in Order.

1. Anesthetize completely the area to be included in the operation. Use a 2% Procaine Solution with Epinephrine 1:25,000.

a) *Maxillary Permanent Anterior Teeth.* Infiltration anesthesia is used.

Labial Injections. The upper lip is retracted by the operator's left hand, and the labial and palatal area to be anesthetized is wiped with a sterile gauze sponge held in the operator's right hand. The dental assistant sprays the area with Solution of Merthiolate. A few drops of the anesthetic solution are deposited just below the mucous membrane at the muco-labial fold over the entire area to be anesthetized. Subperiosteal injections follow and are made mesially and distally to the apices of the teeth to be resected. 1½ cc. of anesthetic solution is deposited slowly in making the above injections.

Palatal injections. Supraperiosteal injections are made in the palate over the apices of the teeth to be resected. ¼ to ½ cc. of the anesthetic solution is deposited slowly in making the palatal injections.

b) *Mandibular Permanent Anterior Teeth.* Mandibular block anesthesia supplemented by subperiosteal labial infiltration is the method of choice for lower permanent anterior teeth.

Mandibular Block Injections. Prepare the tissue through which the injections are to be made by wiping the points of injection with a sterile gauze sponge. The dental assistant sprays the areas with Solution of Merthiolate. With the ball of the index finger of the free hand, palpate the anterior border of the ramus of the mandible and note the small depression between the internal oblique line and the ptergomandibular ligament — the ptergomandibular triangle, approximately one cm. above the occlusal plane of the lower teeth. Keep the ball of the finger in this depression, with the nail turned toward the median plane. Hold the syringe so that the barrel lies in the bicuspid region of the opposite side, and guided by the center line of the nail of the palpating index finger, introduce the needle with the bevel toward the periosteum until it encounters the bone of the internal oblique line. Deposit a few drops of solution so that the further introduction of the needle and any necessary reinjection will be painless. Withdraw the needle slightly and move the soft tissue and the needle toward the median plane with the palpating index finger.

The needle is directed slightly downward to compensate for the obtuse angle formed by the ramus with body of the mandible in children. As soon as the internal oblique line and the temporal tendon are cleared, swing the barrel of the syringe distally a trifle farther, if possible, and advance the needle carefully until it encounters bone. Retract the needle very slightly and deposit one cc. of anesthetic solution. When the needle does not encounter bone after it has penetrated to a depth of 1.5 to 2 cm., withdraw the needle and try again, keeping the barrel of the syringe as far distally as possible on the opposite side of the mouth. It is quite possible to advance past the ramus in a child and into other structures beyond. When bone is encountered, one has the assurance that he is not injecting into muscles or into structures outside the desired area.

The bilateral mandibular block is employed for all resections on lower permanent anterior teeth because it is often necessary to extend the incision across the mid-line in order to provide proper access to the field of operation, and to secure profound anesthesia. Before proceeding with the labial injections, wait for symptoms of anesthesia. At the expiration of three minutes inquire of the child regarding a tingling sensation, numbness or stiffness on both sides of the lower lip and chin. If symptoms of profound anesthesia fail to appear within three minutes after the injections have been given, re-inject on the side on which anesthesia is incomplete.

Failure to obtain profound block anesthesia on children is usually

due to insufficient knowledge of the variations in anatomy of children of different ages. Failure to obtain anesthesia with the mandibular block in children may be due to injecting: (1) Too low (below the lingula); (2) Too high (into the sphygmoid notch); (3) Too deep (into the parotid gland); (4) Too far lingually (into the internal ptergoid muscle).

Labial Injections. Prepare the tissue through which the injections are to be made by wiping the area to be anesthetized with a sterile gauze sponge. The dental assistant sprays the area with Solution of Merthiolate. 1 cc. of anesthetic solution is deposited under the periosteum mesially and distally to the apices of the teeth to be resected.

2. The lip is held back by the operator's left hand and the labial area to be covered by the incision is sprayed with merthiolate solution by the dental assistant. The operator makes a slightly curved incision, not less than one inch in length, through the mucoperiosteum to the bone. The incision is made incisally to the point of resection as shown by the radiograph, but not too near the gingival border as necrosis of this may occur. A fistula, if present, must be included in the flap. A long incision helps to avoid traumatizing the flap by avoiding tension of retraction at the corners. The frenum of the lips should not be cut. When both central incisors are being resected, the center of the incision is made at the junction of the frenum and the gum. A Bard-Parker blade No. 15 is used in making this incision.

3. A flap including the periosteum is freely dissected with a Hu-Friedy periosteal elevator No. 10, exposing the labial alveolar bone over the roots to be resected. Holding the periosteal elevator in the left hand, the operator retracts the flap by placing one end of the elevator firmly against the labial alveolar bone above the area to be operated.

4. Apply adrenaline chloride 1:1000 on small squares (half inch) of sterile gauze to check hemorrhage. The gauze squares are placed under the flap and held for about two minutes under thumb pressure before removing. An aspirator is placed in the mouth at this point to remove excess saliva, medicaments and blood.

5. The area of periapical pathology is often apparent due to the bulging, thinness or perforation of the overlying alveolar bone. A window is made through the overlying bone exposing fully the apices of the roots to be resected, and the entire periapical area of pathology. A sterile Henahan surgical bur No. 42 and sharp, double-end Hu-Friedy curettes No. 10 and No. 11, are used to remove the overlying bone. (Be careful not to puncture the granuloma or cyst thereby liberating the contents which may be septic.)

6. With the aid of the radiograph and a sterile Cleve-Dent No. 1 explorer, determine the point of sound peridental membrane for each root to be resected. Each root is amputated just below this point by means of a sterile cross cut fissure bur No. 558. The root end is cut off with a flat or an oblique cut. An oblique cut is used only when the peridental membrane is destroyed farther on one side of the root than on the other, and retention would be jeopardized by cutting the root flatly at the lowest point of healthy attachment.

7. Loosen the attachment of the granuloma or cyst from the walls of the bone cavity and dislodge the amputated root apex by means of the Hu-Friedy curette No. 10. Remove *en masse* the root apex and attached granuloma or cyst by means of a small sterile hemostat.

8. If the necrotic tissue lining the cavity is not removed intact, curette the remainder until the bone cavity is entirely free of all pathological debris.

9. Smooth the root end and the rough edges of the bone cavity by means of a sterile No. 9 round bur. With a warm Cleve-Dent No. 25 ball burnisher, compress the end of the gutta percha root canal filling to insure a good seal.

10. Recheck for sound periodental membrane around the periphery of the amputated root end with a sterile Cleve-Dent No. 1 explorer.

11. Wash out the bone cavity with boiled Physiological Saline Solution followed by 15 drops of fresh Tri-Chlor followed again by boiled Physiological Saline Solution.

12. Draw sufficient blood to fill the cavity by slightly irritating the surrounding tissues by means of a curette.

13. Replace the flap and suture using medium dermal sutures and a No. 18 half-round cutting edge surgical needle. Four to six interrupted sutures will usually suffice. Be sure that the sutures pass through sufficient bulk of tissue including the periosteum to hold without cutting through.

14. Spray the incision with Solution of Merthiolate.

15. Take a radiograph of the area operated immediately after the operation has been completed.

This conventional method of filling the canal before resection has been quite successful in the conservation of permanent anterior teeth of children. However, this method often requires a long drawn out series of root canal treatments before it is possible to get the canal dry enough to properly fill. There has always been some doubt in our mind about the sterility of the periapical area even after repeated treatments with drugs and electromedication. Our attempts to render the contents of a large infected periapical granuloma sterile by treatments through the apical foramen of a tooth seem about as rational as trying to clean out a large room through the key-hole. If this be true, then our chances of success in this method of resection depend largely upon an hermetically sealed root end in the pres-

ence of infection. Colton[7] claims that there is no reliable method of determining the sterility of the periapical area before filling the canal and therefore considers that filling the canal before resection is not good surgery, due to the chance of seepage from the periapical area. This is apparently offset to a great extent by electro-medication.

The post-operative canal filling technique of apicoectomy has been found to have several important advantages over the conventional procedure as described above and is considered better surgery by such authorities as Mead[1], Colton[7], and Feldman[3]. We have found advantages of the technique to be:

1. Less danger of seepage of septic material at the time the root canal is filled because the periapical reservoir of infection has been removed surgically.

2. Less danger of acute symptoms following the sealing of the root canal by gutta percha when there is doubt about the sterility of the periapical area. Appleton[10] states, "Under no circumstances, except in anticipation of immediate root resection, should a root canal be filled while infection of the periapical tissues persist as shown by a positive culture." Many times it is impossible as well as impractical to completely stop seepage from a chronic long standing and extensive periapical infection. Further, it is difficult if not impossible to get two consecutive negative cultures even after prolonged therapy in these cases.

3. Greater economy. We have found it less expensive to resect the root first and then fill the canal, in chronic long-standing and extensive periapical infections than to resort to a long drawn out series of root canal treatments of questionable value before resorting to surgery. Fewer visits, fewer treatments and fewer radiographs are required in the post-operative canal filling technique.

4. Facilitated condensation of the gutta percha root canal filling in teeth with badly curved roots or teeth with broken instruments in the canal.

5. Beneficial to the prognosis of teeth with extensive periapical involvement. If the destruction of the peridental membrane has progressed farther than disclosed by the radiograph and the retention of the tooth is jeopardized, the tooth can be extracted without having wasted valuable time in prolonged root canal treatment.

6. Less Traumatic. Apparently less post-operative swelling and pain follow the apicoectomy—this is possibly due to the fact that no pressure was transmitted to the periapical area during the condensation of the root canal filling.

7. Absence of requirement for a negative culture.

Post-Resection Canal Filling Technique by Steps in Order.

First Visit of Patient with an acute infection: Open the pulp chamber on the lingual with a spade bur. Carefully remove the pulp chamber and

root canal contents with a broach. Flush the canal with Tri-Chlor using an old hypodermic syringe with the point of the needle cut off. Apply electromedication using Churchill's Iodine as the electrolyte. Dose—30 milliampere minutes. Leave the canal open 24 to 48 hours, or until the tooth is comfortable. Treat thereafter as a chronic case.

First Visit of Patient with a chronic infection: Using aseptic technique open the root canal on the lingual surface of the tooth by means of a spade bur. Enlarge the opening on the lingual surface of the crown until it will admit a No. 6 round bur. Remove the contents of the pulp chamber and canal by means of broaches, reamers and files. (2) Flush the canal with Tri-Chlor. (3) Apply electromedication using Churchill's Iodine as an electrolyte. Dose—30 milliampere minutes. (4) Place a J & J absorbent point saturated with Formocresol into the canal and seal with zinc oxide and eugenol cement.

Second Visit for Chronic Cases; Third Visit for Acute Cases:

1. Aseptic technique is followed throughout the operation as described in the conventional resection technique.
2. The area to be included in the operation is completely anesthetized using the same injections as described in the conventional resection technique.
3. Using the same surgical technique as described in the conventional method, turn back a mucoperiosteal flap exposing the alveolar bone over the area of periapical pathology. After cutting a window in the overlying alveolar bone and exposing the roots to be resected, select a point of healthy root and pericementum and cut the root end off just below this point. Dislodge the amputated tip and enucleate intact the granuloma or cyst. Remove *en masse* the root tip and attached granuloma or cyst. Smooth the root end and rough edges of the bone cavity and recheck the peridental membrane around the periphery of the cut root.
4. Flush the bone cavity with Physiological Saline Solution.
5. Place a square of sterile gauze moistened with alcohol into the periapical bone cavity, and replace the flap temporarily.
6. Still using sterile technique remove the zinc oxide and eugenol cement filling on the lingual surface of the crown. Remove the J & J absorbent point with a broach. Flush the canal with Tri-Chlor and dry.
7. Remove the alcohol sponge from the periapical bone cavity and replace it with another.
8. A sterile J & J absorbent point moistened with phenol is used to sterilize the walls of the root canal. The alcohol sponge in the bone cavity catches any overflow.
9. The canal is wiped with 70% alcohol on a sterile J & J absorbent point and dried with another dry sterile point.
10. Select the largest size sterile gutta percha point that will reach through the amputated end of the root. The selected gutta percha point is lightly

covered with Kerr Sealer, carried into the canal and forced into place under pressure with a Kerr No. 1 spreader. Additional very fine gutta percha points are carried into the canal and condensed with a No. 1 Kerr spreader until no more can be placed, thus producing a hard, dense core of gutta percha hermetically sealing the canal.

11. The gauze sponge in the periapical bone cavity is removed and the gutta percha points cut off even with the end of the root by means of a hot Cleve-Dent U. of D. No. 8 plastic instrument. A warm Cleve-Dent ball burnisher No. 25 is used to compress the gutta percha at the end of the cut root and thus insure a good seal.

12. Wash out the bone cavity with boiled Physiological Saline Solution followed by 15 drops of fresh Tri-Chlor followed again by boiled Physiological Saline Solution.

13. Examine the bone cavity for gutta percha, Kerr Sealer or bone debris.

14. Draw sufficient blood to fill the cavity, replace the flap and suture.

15. Take a radiograph of the area operated.

Post-Operative Care

1. Advise the parent and child regarding the home care and the possibility of some swelling. Prescribe a mouth wash of warm saline solution every hour during the first 48 hours.

2. Prescribe an ice bag to the lips over the area during the first 24 hours to prevent swelling. Force fluids, rest in bed and a liquid diet during the first 24 hours.

3. To relieve pain after anesthetic leaves, prescribe aspirin grs. V every four hours as needed.

4. Have the patient return in 48 hours for a progress examination. Clean the incision with an applicator moistened with Tincture of Metaphen.

5. Remove the sutures at the end of ten days.

6. If aseptic technique has been followed throughout, healing should take place without suppuration. Granulations gradually replace the clot and bone regeneration gradually replaces these.

7. If the blood clot breaks down, remove the sutures and pack the cavity with vaselined iodoform gauze. Remove and replace the dressing every 48 hours until the cavity is filled with granulations. Healing takes place by second intention.

8. A progress radiograph is taken four weeks after the operation, another three months after the operation, and further progress radiographs are taken every three months until regeneration of the periapical bone and peridental membrane is complete. Check up radiographs should be taken once a year thereafter.

Summary and Conclusions

Permanent anterior teeth with decomposed pulps and infected root canals in the mouths of children present a difficult problem to the dentist. In such teeth an area of bone destruction around the apex is almost always found upon radiographic examination. The dentist faces the questions: (a) Should an attempt be made to save such teeth? (b) What are the chances for success if apicoectomy is employed?

Regarding the first question, Kronfeld[12] says, "Microscopic findings justify such an attempt . . . The difficulty in treating teeth with decomposed pulps seems to be failure to get complete access to all parts of the root canal and to the diseased area beyond the apex . . . In pulpless infected teeth, unaccessible parts such as ramifications and curved canals continue to act as a source of infection, making healing of the periopical region impossible." Root resections help solve the difficulty presented in treating these teeth.

In answer to the second question, Kronfeld[12] says, "Clinically, it is well known that large areas of bone destruction around the apex of an infected, pulpless tooth may heal completely after the root end has been resected and the pulp canal filled." According to Hill[5], who made a histologic study of resected teeth, the periodontal membrane regenerates over the root end normally. His photomicrographs demonstrated: (1) No polymorphonuclear infiltration (2) No epithelial rests; (3) No epithelial necrosis. Consequently, the life of the new tissue is not endangered, and the tooth may be expected to render useful service for the individual for many years. The studies of Blum[2], Blayney[11], and Coolidge[4], regarding the regeneration of bone and pericementum following a root resection correlate with the findings of Hill[12].

The cardinal principals essential for successful root resections include complete surgical removal of all periapical necrotic tissue, sterilizing and hermetically sealing the root, and the observance of aseptic technique. These principals are based upon resecting 449 teeth of children during the past four years with failures in only approximately 1 percent of the cases, in spite of the fact that the prognosis for many of these teeth was doubtful. Appleton[10] states, "Under favorable conditions this method (apicoectomy) seems to be effective, as far as can be demonstrated by roentgenograms, etc., after five years in about 75 to 80 percent of cases. The procedure saves at least 50 percent of teeth which otherwise would have to be extracted."

Our experience indicates that nearly 99 percent of periapically infected permanent anterior teeth of children can be saved by root surgery if the cardinal principals of apicoectomy as outlined above are employed. Electromedication is used to hasten phagocytosis and reduce inflammation of the periapical tissues. Post-operative swelling and pain is greatly reduced by this pre-operative therapy. Although the conventional pre-operative canal

filling technique has been employed in the majority of teeth resected to date in this clinic, the post-resection canal filling technique is rapidly gaining favor as the method of choice on account of the many demonstrated advantages inherent in this latter procedure. Root resections give children a service frequently unequalled by any other measure available to the dentist. It is a means of saving pulpless permanent anterior teeth which otherwise would have to be extracted; thus preserving esthetics, normal function and preventing malocclusion.

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